ARMY MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

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THE EFFECTIVENESS OF SIZE CUES TO RELATIVE DEPTH AS A FUNCTION OF THE LATERAL SEPARATION OF OBJECTS*

*Subtask under HUMAN ENGINEERING STUDIES, AMRL Project No 6-95-20-001, Subtask, The Relation Between Optical Aids and Perception in Visual Observation.

RESEARCH AND DEVELOPMENT DIVISION
OFFICE OF THE SURGEON GENERAL
DEPARTMENT OF THE ARMY

Army Medical Research Lab. Project No. 6-95-20-001 Report No.125

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W. C. Gogel, G. S. Harker, w/ass't of J. P. Tammaro, K. Inaba & R. L. Brune

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1. Psychology 2. Vision 3. Size cue to depth 4. Depth perception

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by

Walter C. Gogel and George S. Harker
with the assistance of
John P. Tammaro, Kay Inaba, and Robert L. Brune

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ARMY MEDICAL RESEARCH LABORATORY
FORT KNOX, KENTUCKY
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ABSTRACT

THE EFFECTIVENESS OF SIZE CUES TO RELATIVE DEPTH AS A FUNCTION OF THE LATERAL SEPARATION OF OBJECTS

OBJECT

To investigate changes in the effectiveness of size cues to relative depth as a function of the lateral visual separation of two differently sized similiar objects. This can assist in specifying situations in which the influence of the relative size of objects should be considered in the perception of depth.

RESULTS AND CONCLUSIONS

Using situations in which two playing cards were laterally separated by two different amounts, it was found that the apparent depth between the cards as a result of one card being larger than the other increased when the lateral separation of the cards was increased. This occurred when the two cards were viewed binocularly and also when one card was viewed binocularly and the other monocularly. It was concluded that the effectiveness of size cues to relative depth increased as the lateral separation of the differently sized playing cards increased.

The method used to investigate apparent relative depth involved a disc whose path of depth movement always passed over the left binocular playing card. It was found that when the cards were of different size, the adjustment of the disc to the same distance as the right card was less consistent on the average for an individual and more variable between individuals than when the cards were the same size. This occurred when the right card was binocular and also when the right card was monocular.

RECOMMENDATIONS

It is recommended that the conditions which determine the effectiveness of the various cues to relative depth continue to be investigated.

Submitted by:

Walter C. Gogel, Psychologist
George S. Harker, Psychologist
with the assistance of
John P. Tammaro, Kay Inaba, and
Robert L. Brune

Approved: Ray G Daggs
RAY G. DAGGS
Director of Research

Approved: Carl F. Tessmer
CARL F. TESSMER
Lt. Colonel, MC
Commanding

THE EFFECTIVENESS OF SIZE CUES TO RELATIVE DEPTH
AS A FUNCTION OF THE LATERAL SEPARATION OF OBJECTS

I. INTRODUCTION

There have been many studies concerned with the role of size in the determination of apparent distance. Some of these (2, 5, 7, 8, 9, 11, 12, 13) have compared the influence of size with the influence of other factors upon the perception of depth. The effectiveness of size cues to depth may be a function of a number of conditions. These conditions need to be specified before it is possible to predict the relative importance of the size factor in particular situations. The condition with which the present study is concerned is the amount of lateral separation of two similar but differently sized objects. Specifically, the question of this study is whether the effectiveness of size cues upon the perceived relative depth of two objects changes as the lateral visual separation of the two objects is changed.

To answer this question, a method of measurement must be used which is sensitive to changes in the apparent relative depth of objects. A previous study (3) has indicated that a binocular depth illusion will least disturb the perception of the relative depth position of a binocular test object with respect to that part, or object, of the illusion which has the least visual separation from the test object. This separation is the visual separation which occurs on the same fronto-parallel plane when all the objects are projected on this plane from the position of the observer. The application of this to the investigation of apparent relative depth is illustrated by the schematic drawings of Fig. 1. In the top view drawing of Fig. 1-a, the two solid lateral lines represent the physical positions of two simultaneously presented objects A and B which differ only in size and which (in this case) are located at the same distance from the observer. The inner edges of A and B are separated by a distance "L". The long arrow extending from a point between the observer's eyes to object A represents the path along which a test object C is movable in depth. The test object is an object dissimilar to A and B. For example, with A and B rectangular in shape, C (as illustrated in the front view of Fig. 1-a) is a disc. As shown by Fig. 1-a, the path of depth movement of the disc C passes over object A.

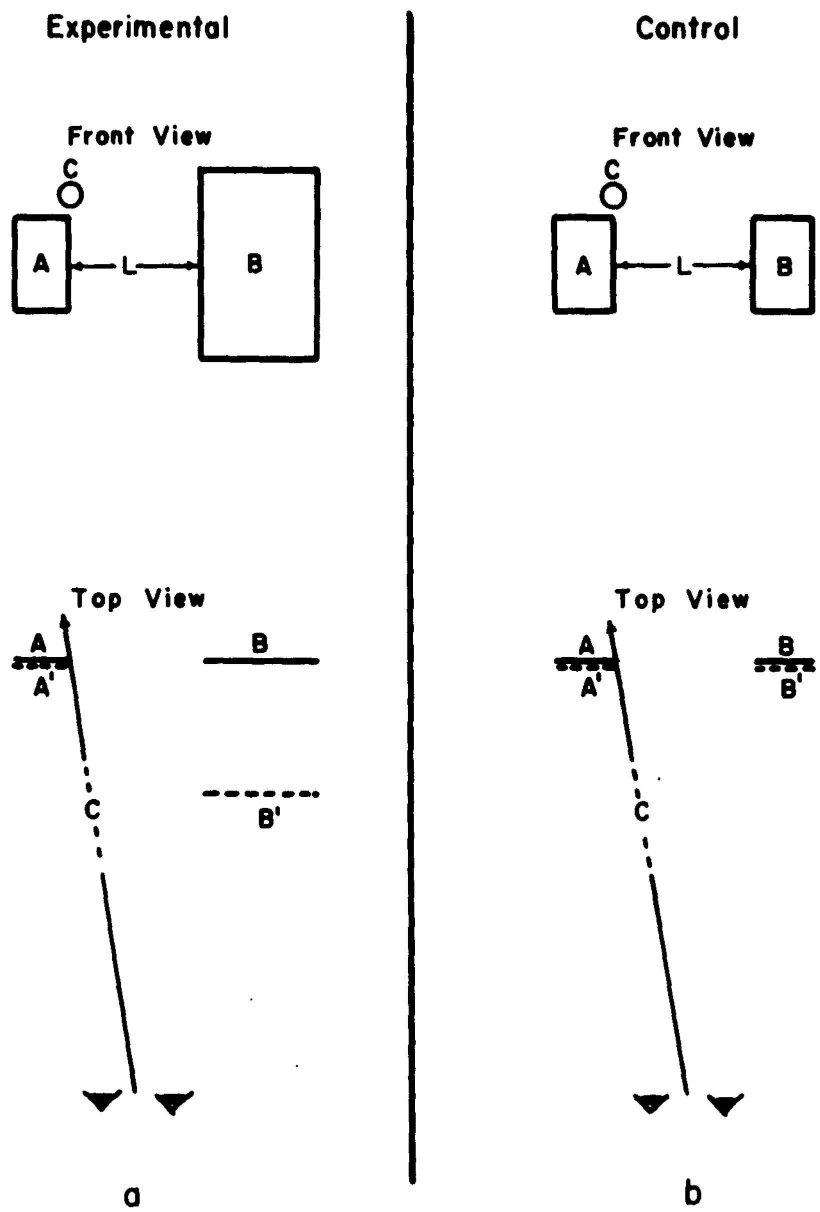

FIG. I. A SCHEMATIC DRAWING OF A METHOD OF INVESTIGATING THE APPARENT DEPTH BETWEEN TWO OBJECTS A AND B.

Since object B is larger than the similar object A, B may appear closer to the observer than A even though A and B are physically equidistant. Objects A, B, and C are all binocular objects. If an observer adjusts C in depth until it appears equidistant with A, the resulting physical depth position of C will be reasonably close to that of A. The physical depth position which A would have to occupy in order to be physically equidistant with the adjusted position of C is indicated by the vertical dotted line A'. The position of A' in Fig. 1-a represents the case in which C appeared equidistant with A when it was physically slightly in front of A. If an observer adjusts C to apparent equidistance with B, however, the resulting physical depth position of C may be considerably closer to the observer than the physical depth position of B. The physical depth position which B would have to occupy in order to be physically equidistant with the adjusted position of C is indicated by the vertical dotted line B'. The position of B' in Fig. 1-a represents the case in which C appeared equidistant with B when it was physically considerably closer to the observer than the physical position of B.

For the adjustment of C to apparent depth equality with either A or B, the path of depth movement of C is that represented in Fig. 1, i.e., the path of the disc is laterally displaced from B but is adjacent to A. If B appears closer to the observer than A, B' will be physically closer to the observer than A'. The physical depth difference between A' and B' is taken as indicating the apparent relative depth between A and B. It is as though in adjusting C to apparent equidistance with B, C is adjusted in depth by the binocular disparity between A and C until it appears as far in front of A as B appears in front of A.

The depth adjustment of the disc C to equidistance with B may differ from the adjustment of the disc to equidistance with A merely because C is laterally more displaced from B than from A. A control situation is needed. This is illustrated by Fig. 1-b. The situation illustrated by Fig. 1-a will be called an experimental situation. The only difference between an experimental and control situation is that, in a control situation, object B is the same size as object A, i.e., A and B are identical. The difference between A' and B' in the control situation can be subtracted from the difference between A' and B' in the experimental situation. The difference which remains is attributed to the effect of the size difference between A and B in the experimental situation. If B is a monocularly viewed object while A is a binocularly viewed object, the same method of investigating apparent relative depth can be used.

This method of investigating apparent distance has some basic similarities to that described by Ittelson (6).

II. EXPERIMENTAL

A. General Apparatus

The binocular disc (object C in Fig. 1) was a haploscopically generated orange disc (15 minutes in diameter) which appeared to move in depth as the instrument knob was turned, with the direction of the motion of the disc depending upon the direction of the knob rotation. This is the same instrument which was used in the previous study (3) except that the instrument was renovated and recalibrated. With the calibration constant of the instrument, and the interpupillary distance of the observer (as measured with a Naval NDRC Interpupillometer), the adjustment of the disc could be expressed in linear distance.

B. Experiment I

1. Display

Fig. 1-a can also be used to illustrate the experimental situations of Experiment I. Two "seven of spades" playing cards were used. Object A (the left card) was a half-sized playing card (4.5 cm. by 2.9 cm.), and object B (the right card) was a double-sized playing card (18.0 cm. by 11.6 cm.). Both of these were presented at the same time in the objective frontal plane of the subject at a distance of 303 cm. from the subject. As indicated by the arrow of Fig. 1-a, the depth path of the disc was always such that it passed over (10 minutes of visual angle above) object A. Two experimental situations were used. These experimental situations differed only in the lateral distance "L" separating the inner edges of the two cards. In one situation, "L" was 3.8 cm., and in the other situation "L" was 22.9 cm.

Also, two control situations were used, one for each experimental situation. These are illustrated by Fig. 1-b. The only difference between the experimental and control situations was that, in the controls, card B was a half-sized playing card instead of a double-sized playing card, i.e., in the control situations both A and B were half-sized playing cards.

The centers of the cards were all at the same height from the floor in all four situations. The subject's eyes were at the level of the centers of the cards. The brightness of the white portions of the cards was adjusted to 2.4 foot-lamberts as measured with a Macbeth Illuminometer. No objects were visible in the subject's field of view except the disc and the two playing cards.

2. Procedure

Eight men who had some experience in using the haploscopic instrument were used as subjects. They were instructed to adjust the disc to the same distance from themselves as an inner edge of one of the cards. This edge was either the right edge of the left card or the left edge of the right card. For simplicity, the object to which the disc was adjusted in depth will be referred to as the left card or the right card. Actually, however, the inner edge of a card was the object to which the disc was adjusted in depth. Sixteen successive adjustments of the disc to depth equality with each card were made by each subject. The subjects were not required to fixate the card. The bracketing technique was used, i.e., the subjects adjusted the disc to appear alternately behind and in front of a card, with the final approach to the same depth position as the card occurring with the disc appearing to move toward or away from the subject, according to the instructions of the experimenter. The direction of this final approach was systematically varied with each subject. Sixteen depth adjustments of the disc to depth equality with one of the two cards was followed by sixteen adjustments to depth equality with the other card. Following this, the subject was asked to give a verbal estimate of the apparent depth between the two cards.

An experimental situation was directly preceded or followed by its control. The lateral separation "L", between the inner edges of the two cards, was the same in an experimental situation and its control. The order of presenting the different conditions was systematically varied between observers with respect to 1) whether an experimental situation was presented before or after its control situation, 2) the order of designating the inner edge of the right or left card as the object to which the disc was adjusted in depth, and 3) the order of presenting the two different amounts of lateral separation between the cards.

3. Results

The summarized results in centimeters from this experiment are shown in Table 1. Each of the means of Table 1 is an average of eight scores, one from each subject, where each score is an average of sixteen depth equality adjustments of the disc to a particular card in a particular experimental or control situation. The standard deviation of each of these distributions of eight scores is shown in Table 1, directly to the right of the means. The column of Table 1 labeled "Mean Difference" gives the differences in centimeters between means and between combinations of means. For example, the difference between the average depth adjustments of the disc on the half - and double-sized card, using the 3.8-cm. lateral separation, was 0 cm. (300 cm. minus 300 cm.). The

TABLE 1

MEANS AND STANDARD DEVIATIONS IN CENTIMETERS FROM EXPERIMENT I

Results from the depth adjustments of the disc on two equidistant binocular playing cards with two different amounts of lateral separation between the cards. N = 8.

	Left Card		Right Card		Mean Difference	t	p
	Mean	SD	Mean	SD			
3.8-cm. Lateral Separation							
Experimental	300	8.4	300	9.7	0	---	---
Control	302	7.9	303	7.1	-1	0.9	>.10
Difference a					1	0.5	>.10
22.9-cm. Lateral Separation							
Experimental	300	9.6	278	18.4	22	3.5	<.01
Control	299	7.9	302	11.9	-3	0.8	>.10
Difference b					25	4.2	<.01
Difference b - Difference a					24	3.8	<.01

results from the "t" test and the probability values (p) associated with these results for the two-tailed test are shown in the last two columns of Table 1. In calculating the "t" value, a distribution of difference scores was formed from the distributions whose mean difference was to be tested for significance.

A standard deviation in Table 1 indicates the variability between subjects of the means of a set of sixteen adjustments of the disc to equidistance with a particular card in a particular experimental or control situation. The consistency of a subject on a particular card in a particular situation would be indicated by the standard deviation of that set of sixteen depth adjustments of the disc by that subject. When such standard deviations had been computed for each of the subjects, the average standard deviation for the eight subjects on a particular card in a particular situation could be found. These are given in Table 2. Each of the standard deviations of Table 2 is an average of eight standard deviations where each of the latter was computed from a set of sixteen depth equality adjustments of the disc to a particular card for each subject.

TABLE 2

AVERAGE STANDARD DEVIATIONS IN CENTIMETERS FROM
EXPERIMENT I

	3.8-cm. Lateral Separation	
	Left Card	Right Card
Experimental	3.4	4.9
Control	3.0	3.9
	22.9-cm. Lateral Separation	
	Left Card	Right Card
Experimental	3.2	11.4
Control	3.7	5.4

The average verbal report of the apparent depth between the two cards in the various situations and the standard deviations of the distributions of verbal reports is given in Table 3.

TABLE 3

MEANS AND STANDARD DEVIATIONS OF THE VERBAL REPORTS FROM
EXPERIMENT I

	3.8-cm. Lateral Separation	
	Mean	SD
Experimental	A 20 inches behind B	40 inches
Control	A 1 inch behind B	7 inches
	22.9-cm. Lateral Separation	
	Mean	SD
Experimental	A 34 inches behind B	56 inches
Control	A 2 inches behind B	7 inches

4. Discussion

The problem of this experiment is whether the effectiveness of size cues to relative depth changes as the lateral separation of the binocular cards is changed. The binocular disparity cue from the two physically equidistant cards would make the cards appear equidistant from the subject. Opposed to this binocular factor in the experimental situations is the size cue which would make the right card appear closer to the subject than the left card. When the lateral distance between the two differently sized cards was 3.8 cm., the mean adjustment difference of the disc on the two cards was 0 cm. (300 cm. minus 300 cm. in Table 1). When, however, the lateral distance between the two differently sized cards was 22.9 cm., the mean adjustment difference of the disc on the two cards was 22 cm. (300 cm. minus 278 cm. in Table 1). In order to conclude that the effectiveness of the size cue increased with the increase in lateral separation, it must be demonstrated that this increase in apparent depth would not have occurred in the absence of size differences between the cards. For this reason, the results from the control situations in which both the left card (card A of Fig. 1-b) and the right card (card B of Fig. 1-b) were the same size must be considered. As shown in Table 1, the mean adjustment difference of the disc between the experimental situation and the control situation with the 22.9-cm. lateral separation (difference b) was larger in magnitude than the mean adjustment difference between the experimental situation and control situation with the 3.8-cm. lateral separation (difference a) at the .01 level of confidence. It appears from this that the effectiveness of the size cue to relative depth increased with the increase in the visual lateral separation of the similar binocular objects. The data on which this conclusion is based is in linear measure. But the dial readings of the haploscopic instrument can be converted to either linear or angular measure. Since these two measures are not linearly related, it is of interest to determine whether the statistical conclusions are dependent upon which of the two measures is used. A parallel analysis of the data in angular measure (shown in the appendix) supports the conclusion that the effectiveness of the size cue to relative depth increased with the increase in the visual lateral separation of the differently sized playing cards.

As indicated by the standard deviations of Table 3, the verbal reports of the apparent depth between the two cards in the experimental situations varied widely between subjects. The difference between the average verbal report from the experimental situation and control situation, with the 22.9-cm. lateral separation, is greater than the difference between the average verbal report from the experimental situation and control situation with the 3.8-cm. lateral separation. This is in agreement with the results from using the disc. But, unlike the results from using the disc, this over-all result is below the 5 per cent level of confidence ($t = 2.0$). It might be questioned whether the subjective standard by which the verbal estimate was made (in this and the following experiment) remained constant from situation to situation. Also, the verbal estimates might have involved some tendency to report size differences as depth differences instead of estimating the apparent depth directly.

As might be expected (4, 10), in both the experimental and control situations, the average standard deviations of Table 2 were larger for the depth adjustments of the disc on the right card than on the left card

Also, the average standard deviation of the depth adjustments of the disc on the right card in an experimental situation was larger than that in a control situation, with this difference increasing as the lateral separation of the cards was increased. A similar pattern of changes in standard deviations is found in Table 1. The standard deviations of Tables 1 and 2, suggest that the introduction of a size difference between the cards decreased on the average the consistency of a subject's adjustment of the disc to equidistance with the right card and increased the variation between the mean of these adjustments from different subjects.

The evidence from this experiment is that the size cue became more effective in determining the apparent relative depth of the cards as the lateral visual separation of the differently sized binocular cards increased. It seems that the relative importance of binocular disparity and the size cue in determining the apparent depth between physically equidistant parts of the visual field depends upon the lateral visual separation of the parts.

C. Experiment II

1. Display and Procedure

Experiment II was identical with Experiment I in apparatus and procedure except that 1) a normal-sized playing card (9.0 cm. by 5.8 cm.) was used in the experimental and control situations wherever a half-sized playing card was used in Experiment I; 2) the playing card on the subject's right was always seen monocularly in Experiment II, while the card on the left and the disc were always seen binocularly in Experiment II as in Experiment I; 3) sixteen, rather than eight, subjects were used in Experiment II.

The monocular view of the right playing card was produced by adjusting a black cardboard to obscure part of the field of view of the subject's right eye. With his right eye, the subject saw the disc and only the left playing card. The disc and both playing cards were visible with the left eye. Since there was no binocular disparity cue between the two playing cards, the normal-sized playing card was used instead of the half-sized playing card, in an attempt to limit the apparent depth difference between the two cards. If this apparent depth difference was too large, the subject, in attempting to adjust the haploscopically generated disc to depth equality with the left edge of the right card, would exceed the fusion limits of the binocular disparity between the disc and the left card by means of which the depth adjustment of the disc was made.

Sixteen men who were experienced in using the haploscopic instrument were used as subjects. Seven of these had previously been used in Experiment I. No objects were visible to the subjects except the disc and the two cards. The brightness of each of the two cards was adjusted to 2.4 foot-lamberts.

2. Results

The summarized results in centimeters from this experiment are shown in Table 4. The arrangement of Table 4 is the same as that of

TABLE 4

MEANS AND STANDARD DEVIATIONS IN CENTIMETERS FROM EXPERIMENT II

Results from the depth adjustments of the disc on two equidistant playing cards, one binocular and one monocular, with two different amounts of lateral separation between the cards. N = 16.

	Left Card		Right Card		Mean Difference	t	p
	Mean	SD	Mean	SD			
3.8-cm. Lateral Separation							
Experimental	303	4.2	287	14.9	16	5.2	<.001
Control	304	5.0	307	9.4	-3	1.5	>.10
Difference a					19	5.4	<.001
22.9-cm. Lateral Separation							
Experimental	304	4.2	270	30.5	34	4.7	<.001
Control	305	5.2	307	12.1	-2	0.7	>.10
Difference b					36	4.7	<.001
Difference b - Difference a					17	3.3	<.01

Table 1. Each mean in Table 4 is an average of sixteen scores, one from each subject, where each score is an average of sixteen depth equality adjustments of the disc to a particular card in a particular situation. The standard deviations of each of these distributions of sixteen scores (one score from each subject) is shown in Table 4 directly to the right of the means. Table 4, like Table 1, gives the "t" and probability values (p) resulting from testing the significance of the differences between means and between combinations of means. As in the analysis of the results of Experiment I, a distribution of difference scores was formed from the distributions whose mean difference was to be tested for significance.

The standard deviations of Table 4 represent variability between subjects. The standard deviations of Table 5 represent the average consistency of the subjects with a particular card in a particular experimental or control situation. The standard deviations of Table 5 are averages of sixteen

TABLE 5

AVERAGE STANDARD DEVIATIONS IN CENTIMETERS FROM EXPERIMENT II

3.8-cm. Lateral Separation		
	Left Card	Right Card
Experimental	2.3	4.9
Control	2.1	3.9
22.9-cm. Lateral Separation		
	Left Card	Right Card
Experimental	2.3	8.3
Control	2.4	4.3

standard deviations where each of the latter was computed from a set of sixteen depth equality adjustments of the disc to a particular card in a particular situation for each subject.

The average verbal report of the apparent depth between the two cards in the various situations and the standard deviations of the distributions of verbal reports are given in Table 6.

TABLE 6

MEANS AND STANDARD DEVIATIONS OF THE VERBAL REPORTS FROM EXPERIMENT II

3.8-cm. Lateral Separation		
	Mean	SD
Experimental	A 19 inches behind B	30 inches
Control	A 1 inch in front of B	3 inches
22.9-cm. Lateral Separation		
	Mean	SD
Experimental	A 27 inches behind B	37 inches
Control	A 0 inches behind B	3 inches

3. Discussion

In this experiment, since the right card was always monocularly viewed, no disparity cue existed between the two cards. As shown in Table 4, in this experiment as in Experiment I, the change in the mean adjustment difference of the disc on the two cards from the experimental situation to the appropriate control situation was larger in magnitude with the 22.9-cm. lateral separation (difference b) than with the 3.8-cm. lateral separation (difference a) at the .01 level of confidence. A parallel analysis of the data in angular measure (shown in the appendix) supports this conclusion. In this experiment, also, size cues became more effective in determining apparent relative depth as the lateral visual separation of the objects was increased. As shown in Table 6, the difference between the average verbal report from the experimental situation and control situation with the 22.9-cm. lateral separation is greater than the difference between the average verbal report from the experimental and control situation with the 3.8-cm. lateral separation. But, as in Experiment I, this over-all result is below the 5 per cent level of confidence ($t = 1.6$).

The pattern of changes in the standard deviations, both the mean standard deviations (Table 5) and the standard deviations of the means (Table 4), is similar to that of Experiment I. This suggests that the introduction of a size difference between the cards, when the card to which the disc was adjusted in depth was the right card (the monocular card), decreased the average consistency within a set of sixteen adjustments for a subject and increased the variation of the mean adjustment between subjects.

III. GENERAL DISCUSSION

The results from these two experiments indicate that the effectiveness of size cues to relative depth increased with the increase in lateral separation of the similar objects, both in the situation in which binocular disparity between the similar objects was present and in the situation in which binocular disparity between the similar objects was absent. In the experiment in which the right card was seen monocularly, the results can be explained either by the strength of the size cue increasing with increased lateral separation or by the strength of some factor which would tend to make the cards appear equidistant, decreasing with increased lateral separation. The results from an experimental investigation of this latter possibility will be presented in a future report.

The path of apparent depth movement of the disc in both experiments always passed over the left card and was laterally displaced from the right card. It will be observed that the average adjustment of the disc to equidistance with the left card was always reasonably correct, i.e., the disc was placed at approximately the physical depth position of the left card (303 cm.). In three out of four of the experimental situations, the average adjustment of the disc to equidistance with the right card was incorrect in terms of the actual location of this card. It should not be concluded from this that all the difference between the physical and apparent relative depth of the cards occurred with the right card. For example, if the path of depth movement of the disc had been over the right card and laterally displaced from the left card in the experimental situation with the 22.9-cm. lateral separation in Experiment I, the average adjustment of the disc to equidistance with the left card would have been incorrect in terms of the physical depth position of this card.

The similarity of the average adjustment of the disc to equidistance with the binocular left card in Experiment I and Experiment II is consistent with a study by Alluisi and Harker (1) in which changing the size of a binocular card (this was the only card in the field of view) generally had little or no effect upon the average adjustment of the disc to equidistance with this card.

IV. SUMMARY AND CONCLUSIONS

The two experiments of this study investigated the effect of increasing the lateral separation of two differently sized playing cards upon their apparent relative depth positions. The two cards were physically located at the same distance from the subjects. Two different amounts of lateral separation between the two cards were used. Controls were employed to determine the effect of the increased lateral separation upon apparent relative depth when both cards were the same size. It was found that the average apparent depth between the two differently sized, similar cards increased as the visual lateral separation of the cards increased and that an equivalent change did not occur when both cards were the same size. This happened both when the two cards were binocular and when one card was binocular and the other monocular. It is concluded that the effectiveness of size cues to relative depth increased as the lateral separation of the differently sized, similar cards increased.

The method used to investigate apparent depth involved a disc whose path of depth movement always passed over the left binocular playing card. It was found that when the cards were of different size, the adjustment of the disc to equidistance with the right card was less consistent on the average for a subject and more variable between subjects than when the cards were the same size. This occurred when the right card was binocular and also when the right card was monocular.

V. RECOMMENDATIONS

It is recommended that the conditions which modify the effectiveness of the various cues to relative depth continue to be investigated.

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VII. APPENDIX

Each angular mean shown in Table 7 is an average of eight angular scores from Experiment I, one score from each subject. Each angular score is an average of sixteen adjustments of the disc to depth equality with a particular playing card in a particular experimental or control situation. Before averaging the eight angular scores, each score in mintues of angle was divided by the interpupillary distance of the subject in centimeters. The angle measured was the angle formed between the two image-carrying beams of light in the haploscopic instrument, one beam going to one eye of the subject and the other beam going to the other eye. It will be observed that "difference b" minus "difference a" is significant at the .01 level of confidence. This indicates that the average difference between the depth equality adjustments of the disc on the left and right card as a consequence of the size difference of the cards was significantly greater with the 22.9-cm. lateral separation than with the 3.8-cm. lateral separation between the two cards. This suggests that the effectiveness of the size cue increased when the lateral separation of the two differently sized similar cards was increased.

Each angular mean shown in Table 8 is an average of sixteen angular scores from Experiment II, one score from each subject. Each angular score is an average of sixteen adjustments of the disc to depth equality with a particular playing card in a particular experimental or control situation. Before averaging the sixteen angular scores, each score in minutes of angle was divided by the interpupillary distance of the subject

TABLE 8

MEANS IN ANGULAR MEASURE FROM EXPERIMENT II

Average results from the depth adjustments of the disc on two equidistant playing cards, one binocular and one monecular, with two different amounts of lateral separation between the cards. N=16.

3.8-cm. Lateral Separation					
	Left Card	Right Card	Difference	t	p
Experimental	11.4	12.1	-0.7	4.6	<.001
Control	11.4	11.3	0.1	1.4	>.10
Difference a			-0.8	4.9	<.001
22.9-cm. Lateral Separation					
	Left Card	Right Card	Difference	t	p
Experimental	11.3	13.0	-1.7	4.0	<.01
Control	11.3	11.3	0.0	---	---
Difference b			-1.7	4.0	<.01
Difference b - Difference a			-0.9	3.1	<.01

in centimeters. The angle measured was the angle formed between the two image-carrying beams of light in the haploscopic instrument. "Difference b" minus "difference a" is again significant at the .01 level of confidence, which suggests that in this experiment, also, the effectiveness of the size cue increased when the lateral separation of the two differently sized similar playing cards was increased.